State of New Hampshire
Strategic Information Technology Plan – GIS
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The New Hampshire Strategic Information Technology Plan for GIS has been developed over a two-year process, beginning in the summer of 2000, under the auspices of the NH GIS Advisory Committee. We acknowledge the following current and former members of the committee who have contributed time and writing duties to the creation of this document:

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New Hampshire Strategic Information Technology Plan – GIS

1.0 Introduction: Organization of GIS Activities in New Hampshire

A geographic information system (GIS) is a type of information technology which facilitates the collection, manipulation, analysis, and display of spatial data. GIS involves the interplay of software, hardware, data, and personnel to obtain answers to questions about the locations of objects or conditions and their spatial relationships to each other. It has been estimated that nearly 90% of the data collected in traditional databases have some type of spatial component -- a specific coordinate location, an address, a zip code, or some other locational reference. Through an intelligent use of mapping, a GIS can capture and utilize that spatial information to add crucial elements of understanding to the analysis of many data sets.

This document is a strategic plan for the ongoing development of GIS activities by State agencies in New Hampshire.

The plan follows a format specified by the New Hampshire Division of Information Technology Management for the development of Information Technology (IT) plans by State agencies. Because New Hampshire GIS consists of the cooperative efforts of many State and other agencies, there will be some departures in this document from the traditional IT plan approach.

State GIS activities may be placed into two broad categories: 1) activities of individual State agencies; and 2) cooperative GIS efforts, most notably expressed in the development of GRANIT, which is New Hampshire's statewide geographic information system.

1.1 Individual State Agencies

State agencies which currently employ GIS technology include the Departments of Transportation, Environmental Services, Safety, Fish and Game, Health and Human Services, Resources and Economic Development, Justice**,** and Agriculture, as well as the Offices of State Planning, Emergency Management, the Adjutant General**,** and the Public Utilities Commission. Each of these agencies employs at least one person with skills in GIS analysis, and a few (notably Transportation and Environmental Services) employ several. In addition, a significant amount of GIS work is performed at the University of New Hampshire, including contractual work for State agencies.

1.2 Cooperative GIS Efforts

New Hampshire's cooperative GIS activities comprise the system known as GRANIT (for Geographically Referenced ANalysis and Information Transfer system) and are currently coordinated through the state GIS Advisory Committee.

GRANIT

The GRANIT system is a cooperative effort by numerous State agencies (with the help of federal and local agencies) to produce a comprehensive set of GIS data layers for New Hampshire. All State agencies which are cooperatively developing, sharing, and distributing GIS data for New Hampshire are considered part of the GRANIT effort. In addition, Federal, regional, municipal, and private organizations which coordinate with State agencies in GIS development are considered to be "contributing" to the GRANIT effort. GRANIT data is primarily stored at and distributed by Complex Systems Research Center on the campus of the University of New Hampshire. Additional GRANIT data is maintained and distributed by individual State and cooperating agencies in various locations.

NH GIS Advisory Committee

The New Hampshire GIS Advisory Committee is a subcommittee of CORD, the Council on Resources and Development. Its purpose is to steer the development of New Hampshire's GIS by providing a forum for discussion of member agencies' GIS activities. Membership on the committee is open to representatives of State agencies which are involved in GIS activities, as well as cooperating federal and regional planning agencies. Meetings are open as well to any other interested parties. The committee, which meets every two months, is empowered by CORD to propose standards for New Hampshire GIS operations. The GIS Advisory Committee is the body which is responsible for the development of this statewide strategic GIS plan. For the past several years, however, the Advisory Committee has functioned more as a GIS users' group than a policy committee. It will be one of the recommendations of this plan that a new group, consisting of administrators of State agencies which use GIS, be formed to steer GIS policy issues, and that the current GIS Advisory Committee continue as a State GIS users' group and be given a name that more accurately reflects its activities.

1.3 "NH GIS" and "GRANIT"

While essentially all State GIS activities are related in some manner to GRANIT, this document proposes goals and actions for the development of State GIS capabilities as viewed from a higher, strategic level. Of necessity, though, there will be some recommendations, especially in the area of data development, which will fall largely under the purview of GRANIT operations occurring at Complex Systems Research Center at the University of New Hampshire. It is not the purpose of this plan to dictate the specific internal GIS activities of individual State agencies. Rather, the intent is to provide an overlying framework for State government GIS use as a whole, so that individual agencies' decisions can complement each other, rather than work at cross-purposes.

2.0 NH GIS Strategic Business Plan

2.1 NH GIS Mission

The mission of New Hampshire GIS activities is to promote the efficient use of New Hampshire's diverse resources by utilizing geographically related information in an effective way and by providing geographic information and corresponding tools to citizens and organizations.

2.2 Information Technology Vision: **Provision of a broad suite of geographic information to State agencies and the public.**

GRANIT is the designated State repository for publicly accessible, spatial data about New Hampshire. State agencies shall utilize GRANIT data for their GIS activities, whenever the appropriate data exists. Where new geographic data must be developed, it shall be done using software and methods that are compatible with existing GRANIT data. State agencies will remain sensitive to issues of privacy and confidentiality surrounding individual data layers, and will respect the requests of the data custodian on this topic. In order to facilitate data sharing between agencies, data sets will contain standardized metadata relative to their source, accuracy, and proper usage.

2.3 NH GIS Business Functions

According to the draft Statewide Information Technology Plan, the activities of New Hampshire State government fall into six broad business categories: resource management (protection of natural resources and planning for economic development), infrastructure development (primarily transportation), public education, public safety and justice, protecting health and welfare, and administrative support. These functions depend heavily on various forms of general information technology. In addition, each functional area is already making extensive use of GIS technology or is poised to do so.

Historically, State government GIS efforts in New Hampshire have focused on the areas of resource management and infrastructure. In **resource management**, the Department of Environmental Services has used GIS technology since 1990 to track the locations of environmental threats and to designate protection zones for resources such as water supply. The Departments of Fish and Game, Resources and Economic Development, and Agriculture have used GIS to manage wildlife populations, monitor rare and endangered species, track the application of pesticides, and inventory the locations of land holdings. In **infrastructure**, the Department of Transportation has made extensive use of GIS to inventory State roads, prioritize transportation projects, and plan individual construction works.

The four remaining State government business functions also benefit from GIS analysis. In each case, initial GIS activity is now underway and is expected to increase in the future. In **public education**, GIS is helpful in comparing demographic data to provision of education services, but at present GIS is being used only sporadically at the State level. In **public safety**, emergency dispatch through Enhanced 911 is greatly expedited through the linkage of phone numbers and addresses to spatial databases. Also, efforts are underway to equip State Police vehicles with GIS software to assist in officer deployment. Geographic coding of accidents and crimes will allow for the performance of analyses aimed at reducing their future incidence. In the area of **health and welfare**, efforts are now underway at the Department of Health and Human Services to increase the use of GIS in analyzing both the spatial distribution of health hazards and the provision of services. Finally, in **administrative support**, GIS can aid decision-making processes, such as when constructing new State facilities or reviewing locations of existing offices, and in using Census data to create new voting district boundaries.

GIS use continues to increase at other governmental levels as well**.** At the municipal level, resource protection and administrative support (specifically property ownership mapping) are the two most common business functions for GIS. At the level of the regional planning commissions, resource protection, infrastructure, and administrative support are all important functions. Here, administrative support primarily involves aid to individual municipalities for a wide variety of GIS projects. The December 2000 *Survey of GIS Use in New Hampshire* found that the most common applications for GIS among all levels of government were: 1) land use planning (62.5% of systems reporting); 2) natural

resource protection (56.25%); and 3) parcel mapping (53.125%). *(See Appendix 1 for complete survey results.)*

2.4 Program Goals and Performance Objectives

This section identifies the goals, objectives and measures which arise from this document's vision for New Hampshire GIS. Goals as stated here are interdependent; therefore, their order does not necessarily indicate priority.

Goal #1: GRANIT is the repository of NH GIS data and standards for State agencies and the public.

Objective 1.1 Legally establish GRANIT as the State repository for NH GIS data and standards.
Measure 1.1.a Legislation establishing GRANIT as the State repository for NH GIS data and standards. *Date to accomplish: Winter 2003*
Measure 1.1.b Establishment of GRANIT Steering Committee, comprising administrative officials from State agencies which provide funding to GRANIT, plus representatives from UNH-Complex Systems Research Center. *Date to accomplish: Winter 2003*
Measure 1.1.c Creation of link to GRANIT from Webster, the NH State government web page. *Accomplished Fall 2001.*

Objective 1.2 Secure stable and sufficient funding for GRANIT activities centered at Complex Systems Research Center at the University of New Hampshire.
Measure 1.2 Funding is secured. *Date to accomplish: 2003*

Objective 1.3 Broaden public access to geospatial technology.
Measure 1.3 Number of web-based mapping applications accessible to the public increases.

Goal #2: Increase level of GIS use and GIS literacy among State agencies.

Objective 2.1 Establish position of State GIS Coordinator.
Measure 2.1 State GIS Coordinator position is established at UNH-Complex Systems Research Center. *Date: 2003*

Objective 2.2 Evaluation by individual State agencies of their necessary level of GIS use.
Measure 2.2a. State agencies will conduct GIS needs assessments.
Measure 2.2b. State agencies will incorporate GIS needs in their Information Technology plans.

Objective 2.3 Subsequent to evaluation, incorporation by State agencies of the appropriate level GIS technology.
Measure 2.3 Increase in GIS incorporation by State agencies, including any or all of the following components, as dictated by agencies' individual GIS needs assessments: increased usage of prepackaged GIS data and applications; new software licenses; GIS training and support for employees; generation of spatial data; increase in range and sophistication of GIS analysis.

Objective 2.4 Establish GIS-related job classifications in State personnel system.
Measure 2.4 GIS job classification established. *Date to accomplish: 2003*

Goal #3: Encourage the growth of a New Hampshire workforce that is skilled in the use of GIS and related geospatial technologies.

Objective 3.1 Increase the availability and variety of geospatial training for State employees.
Measure 3.1a. Establish State contract for geospatial training with a qualified provider. *Date to accomplish: Fall 2002*
Measure 3.1b. State agencies will participate in founding of geospatial technology training center (separate effort spearheaded by UNH Cooperative Extension Office). *Date: Ongoing.*

Objective 3.2 Incorporate GIS theory and practice at appropriate levels in secondary and post-secondary education.
Measure 3.2a. Incorporation of GIS issues in Education Technology Plan published by the NH Department of Education.

Goal #4: Ensure that GIS data is developed and maintained in a consistent format among agencies.

Objective 4.1 Establish a software standard for GIS use.
Measure 4.1 The Division of Information Technology and Management will publish a standard establishing ESRI products as the software to be used by State agencies.

(Added Dec. 2002:)
Objective 4.2 As part of the development of the National Spatial Database Infrastructure, establish a New Hampshire I-Team to set priorities for state spatial data development and coordinate those priorities with federal data development agencies.
Measure 4.2a Creation of New Hampshire I-Team. *Date to accomplish: Winter 2003*
Measure 4.2b Publication of New Hampshire I-Plan. *Date to accomplish: June 2003*

3.0 Information Technology Principles

3.1 Statewide Information Technology Principles

Statewide Information Technology Principles (SITP) form the basis for the utilization of information technology to support the mission and programs of New Hampshire GIS. The following sections describe these principles and how they are applied by NH GIS.

3.1.1 Organization Principles

1. The State plans for and provides information technology training for its employees to achieve successful information technology systems.

NH GIS users are aware both of the importance of training for GIS users and of the current dearth of such training. It is one of the objectives of this plan to increase the availability of training for GIS users in New Hampshire.

2. *Statewide planning for information technology is developed involving all affected State Agencies.*

   The State has long relied on the GIS Advisory Committee to be the forum for statewide participation in GIS planning.

3. *Agency business planning drives information technology (IT) planning. Agencies develop well-thought-out and documented IT plans.*

   The GIS SITP contains an inventory of the business functions of State government and an analysis of the relation of GIS technology to those functions.

4. *Business processes are evaluated before the introduction of new information technology.*

   This particular plan, while identifying business processes of State government, is primarily focused on guiding the use in New Hampshire of an existing form of information technology, GIS. Therefore, this principle is only relevant for individual State agencies that are assessing their level of GIS use. The State GIS Coordinator shall work to increase the level of awareness of GIS technology among agencies that are not currently using it.

5. *The State involves all user employees in the information technology process to ensure the [implementation of] successful and effective information systems.*

   This plan has relied on information gathered primarily from administrators of GIS throughout State government and other cooperating agencies. Because of the small size of many GIS operations in State government, most GIS administrators are also the primary users of the system, so there has been ample user involvement in the planning process. Nevertheless, it will be the responsibility of individual agencies, especially the large ones, as they determine their level of commitment to GIS technology, to make sure that input down to the most casual user is received.

6. *Agency management has the responsibility and authority to make resource decisions within the information architecture guidelines.*

   The authors of this plan fully agree. All recommendations of this plan involve guidelines for growth of a State-wide GIS, including data development and data sharing, but it is left to agency administrators to determine the best way for their individual organizations to do their work within the guidelines established by this document.

3.1.2 Application Principles

1. *The business users are leaders and owners for all business application system initiatives and major system modifications. Information technology personnel must be included to provide technical direction and support from the start.*

   This has been true of NH GIS from its beginning in the mid-1980s. Most agencies' GIS operations are under the auspices of a particular program, not the IT office. Most GIS administrators in New Hampshire are geographers, engineers, biologists, foresters, social scientists, or other program-oriented people who have discovered the usefulness of GIS to their

activities. Existing information technology personnel are relied upon for infrastructure support, while an increasing number of persons trained in programming are finding their way into GIS application development.

2. *The State develops and implements information systems which support the business goals and significantly improve the effectiveness and efficiency of all system users.*

   The GRANIT system was conceived in the mid-1980s specifically to support a wide array of State tasks. Members of the State GIS Advisory Committee have always been open to increasing its representation to include users (and potential users) of GIS in new fields. The development of this current plan is occurring in coordination with the creation of a complete, statewide information technology plan.

3. *The State evaluates packaged system solutions prior to developing a custom solution.*

   Most GIS applications in New Hampshire are being performed using readily available software from Environmental Systems Research Institute, Inc. (ESRI), AutoCAD, or MapInfo.

4. *The State has a selected list of application packages that are site licensed and supported. Training is available to allow users to fully utilize the packages.*

   The State has a software purchasing agreement with ESRI for their full range of GIS products. The University of New Hampshire has a site license covering all ESRI products. While training is available in state for ArcView, the basic ESRI software, this plan recognizes the need for additional training at all levels of GIS experience.

5. *The State plans for systems maintenance starting from initial systems development. Planning continues throughout the system's life.*

   GRANIT plans for continuous maintenance of GIS *data*. Individual agencies are responsible for maintenance of the hardware and software components of their GIS.

6. *The State recognizes that all systems have a limited life expectancy and plans accordingly for replacement.*

   The emphasis of NH GIS, through GRANIT, is on data development and sharing. We recognize that standards for data formats change just as surely as software and hardware standards change. While planning for replacement or upgrade of data formats, we must also be sure to maintain older formats as long as they continue to be used to a significant degree by other agencies, including users from municipalities or the general public.

3.1.3 Data Principles

1. *The State recognizes data as an asset and protects and manages it as a valuable public resource.*

   This is a fundamental principle that has driven the development of NH GIS since its inception.

2. *The State gathers only data relevant to its mission and seeks to minimize the burden on those who must provide it.*

   The GRANIT project has a detailed list of precisely which GIS data sets are to be gathered and archived, and which NH agency is responsible. Such an arrangement, publicized to all State agencies involved in GIS, eliminates duplication of effort and shares the burden of data gathering among all interested parties.

3. *Agencies are responsible for the data they collect.*

   While most GRANIT data is housed in the central archive at Complex Systems Research Center at the University of New Hampshire, ultimate responsibility for data accuracy and distribution lies with the agency responsible for collecting that data. Some agencies choose to maintain and distribute their GRANIT data in-house. Some data may be determined by its collecting agency to be sensitive and require prior approval before the data is released. Specific agency responsibilities are listed in the GRANIT Data Catalog.

   Except for existing programs of municipal GIS assistance by the state's regional planning commissions, GRANIT discourages re-distribution of data by any agency that is not responsible for the original creation of the data.

4. *State agencies develop and maintain data definitions.*

   GRANIT data adheres to the Federal Geographic Data Committee's standards on metadata, meaning that all GRANIT data is described in a standard way, from data provenance to definitions of data components. In addition, GRANIT has promoted use of consistent and widely recognized data definitions for years. Examples include promotion of federal FIPS coding for geographic area identification, and standard land use codes for existing land use and land cover inventories.

5. *Departments work together to share information.*

   The State GIS Advisory Committee remains the primary vehicle for sharing information on GIS development between State and federal governmental agencies, non-profit organizations, municipalities, and other interest groups.

   In addition, UNH has developed an enhanced web-based node as a National Spatial Data Infrastructure Clearinghouse. This effort will make the sharing of data between agencies easier due to the use and application of Federal Geographic Data Committee metadata standards for describing and documenting the GRANIT data layers.

6. *The State recognizes the need to allow electronic public access to non-protected data.*

   Up to date NH GIS information is available over the Internet through the GRANIT web site (*www.granit.sr.unh.edu*). Enhancements to the web site to include on-line viewing of GIS data are now underway, and some of the larger State agencies using GIS are developing similar on-line mapping applications.

3.1.4 Infrastructure Principles

1. *The State's infrastructure consists of multiple computing platforms. There is a supported evolution toward a distributed computing architecture, where justified.*

   The current GIS data archive model in New Hampshire includes a centralized storage location for most of the state's GIS data, but with analysis and mapping distributed throughout State government, to be performed by the agencies requiring the work. In the near future, additional computing power will be required as on-line, Internet-based mapping becomes available. Additional research will be required to determine the most efficient use of resources by the State for a comprehensive on-line mapping capability. Options include 1) multiple mapping applications, each maintained by an individual State agency and requiring numerous individual access points; 2) a unified mapping application, centered on a single computing environment, such as through the GRANIT data archive at Complex Systems Research Center; or 3) a unified mapping application that accesses computing power distributed among individual State (and possibly other) agencies.

2. *The State's infrastructure utilizes open systems technology while maintaining proprietary systems.*

   While the bulk of NH GIS data is stored in a proprietary ESRI coverage-based format, ESRI geodatabase structure is SQL-compliant.

3. *Connectivity is maintained within and between State agencies.*

   This is provided by NH SUN, State government's connection to the Internet.

4. *The infrastructure has adequate physical security.*

   State agencies which use GIS adhere to the security requirements of the Division of Information Technology Management.

5. *The State implements proven information technologies, with a controlled introduction of leading edge technologies.*

   GIS software available from ESRI is the de facto standard in the GIS community worldwide. Through the site license that UNH has obtained for ESRI products, the New Hampshire GIS community is able to test new products in a controlled setting before committing to their wholesale adoption.

4.0 Analysis of the NH GIS Environment

The environment for GIS activities in New Hampshire is a highly heterogeneous one, encompassing a wide variety of office sizes, software and hardware capabilities, and level of employee training. GIS activity is occurring at many different levels of government, including municipalities,

regional planning commissions, State agencies, and Federal agencies. At each level of government, there is a range of GIS capabilities, from sophisticated in-house systems down to operations which may perform simple mapping on-site but contract out more resource-intensive analyses. This section will describe some results of the December 2000 *Survey of GIS Use in New Hampshire* and provide detailed descriptions of day-to-day GIS tasks performed by selected agencies.

4.1 NH GIS Operating Environment

4.1.1 Statewide GIS Use

In November of 2000, a survey was mailed to over 300 organizations in New Hampshire who were known or potential users of GIS. Every municipality in the state received a survey, as did 34 State agencies, 11 Federal agencies, all 9 regional planning commissions, and 22 private companies. With a return date extended to January 15, 2001, a total of 158 organizations (52%) responded. All subsequent figures quoted from the survey should be read with an understanding that the response rate was only slightly above one half. While this does not mean that one may multiply the response figures by two to obtain a true number for GIS activities, it is important to remember that the actual numbers of GIS activities in New Hampshire will be greater than the numbers reported here.

Of the agencies who responded, 64 (40.5%) indicated that they operated or had access to a GIS. 48 agencies (75% with GIS access) had an in-house GIS, while the rest relied on one or more contractors. An additional 16 agencies are currently developing plans to implement a GIS.

Data creation is a crucial first step in the development of a GIS. While it is assumed that each agency will have unique data needs and will have reason to develop certain data sets internally, it is also true that large amounts of data can be shared between agencies. The survey results indicate that data sharing in New Hampshire is not as widespread as it could be. 20 of 60 respondents indicated that they did not share data at all, though it is not clear whether this is the result of a policy or simply of not having received any requests for data. 35 of 60 respondents do share data, when the user requests it. Only 4 agencies indicated that they have data available for download over the Internet, and only 1 has the most advanced form of data sharing: a web site where the user may create their own maps.

The New Hampshire GRANIT system has data distribution as one of its primary purposes, and there is now a large amount of data in numerous categories which may be obtained by GIS agencies. *(See Appendix 2 for listing of GRANIT data.)* Of the 64 responding agencies with GIS, 48 (75%) have obtained data from GRANIT.

Within GRANIT, there are different levels of data availability, depending on the data required. Internet mapping is currently under development for a small number of applications. It is expected that the first data areas which will be available for Internet mapping will be public conservation lands and telecommunications facilities. There is more data available for direct Internet download, but it still comprises less than half of the total data available from GRANIT. (Current data sets available for download from www.granit.sr.unh.edu include municipal boundaries, surface water bodies, roads and trails, railroads, pipelines and power lines, digital raster graphics [scanned images of U.S.G.S. topographic maps], digital elevation models, digital orthophotography in quarter quadrangle format, and satellite-derived land cover data from 2001.) The remainder of GRANIT data must be obtained by user request.

The survey attempted to ascertain the types of data that are being created by individual agencies. The responses to the question "What spatial data is being developed by your organization?" were varied and difficult to categorize, highlighting the difficulty of researching the availability of data in New Hampshire outside of the auspices of GRANIT.

4.1.2 Specific GIS environments

GIS environments in New Hampshire are highly heterogeneous in terms of hardware, personnel, and organization. (GIS software, with a few exceptions, is usually one of the ESRI family of products.) While there is no single State GIS office to which all agencies send their GIS work, Complex Systems Research Center at the University of New Hampshire serves as the major State repository for GIS data and performs a wide variety of data development and geographic analysis. Some agencies, such as the Departments of Transportation and Environmental Services, in addition to Complex Systems, have numerous people doing analytical GIS work, while other agencies have only one or two GIS employees. In most agencies, large or small, GIS personnel are attempting to bring GIS power to the desktops of additional employees, through the provision of user-friendly interfaces, whether customized (such as the GIS One-Stop application at Environmental Services) or off the shelf (such as the proliferation of ArcExplorer end-user software at the Department of Transportation). Several detailed descriptions of agency GIS environments, written by regular participants in the NH GIS Advisory Committee, can be found in Appendix 3.

Looking at the State's categories of business functions, it is evident that most GIS environments function in the areas of resource management (Complex Systems, Environmental Services, Fish and Game, regional planning commissions); public safety (Complex Systems, E-911, Emergency Management); and infrastructure (Complex Systems, Transportation, regional planning commissions). GIS is gradually being applied to the area of health and welfare (Dept. of Health and Human Services). There has as yet been little GIS work done in the areas of public education and administrative support, though the Sprawl study authored by the Office of State Planning used GIS analysis to indicate policies the State should follow when making office location decisions.

4.2 NH GIS Technical Environment Trends

There are two major trends occurring within the broad GIS environment which will affect the development of GIS in New Hampshire. The first involves the ongoing rapid evolution of the GIS software and data environment, and the second has to do with the increasing amount of GIS work that can be done over the Internet.

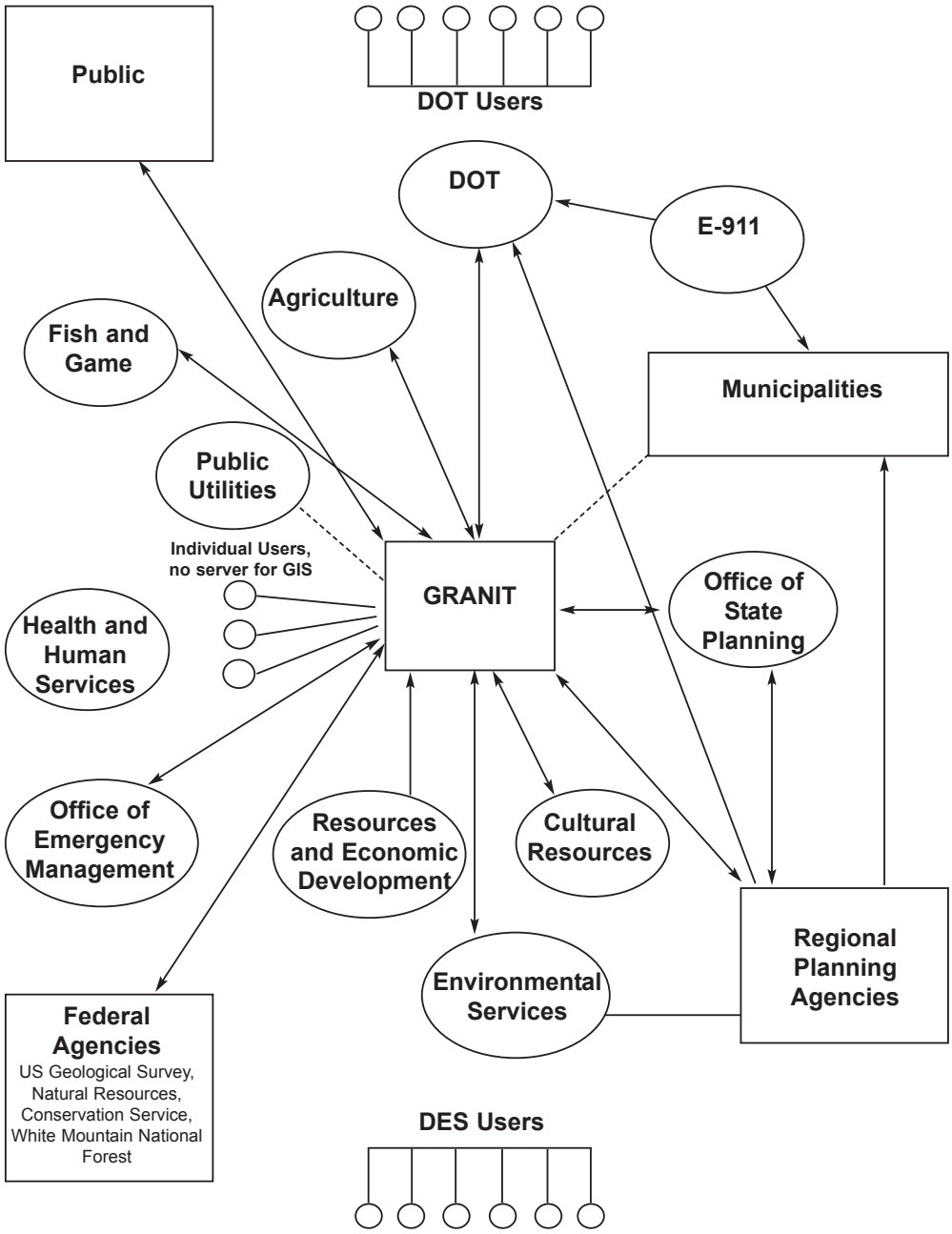
In terms of GIS software and data structure, a change is rapidly occurring in which GIS processes are becoming more tightly interwoven with larger systems that are not specifically GIS-related. This is especially true with the development worldwide of "geodatabases", relational database environments in which geographic data constitute one type of database object. The benefits of geodatabases include rapid query and display of geographic data when large data sets exist. Currently, GRANIT is not set up in a geodatabase format, though individual State agencies such as the Departments of Environmental Services and of Transportation are experimenting with geodatabases. It is likely that GRANIT will eventually convert its data structure to a geodatabase format; however, it is also likely that many data users, especially smaller organizations, will not immediately follow suit. This will result in the need for an

increasing number of formats in which GRANIT data will need to be stored, as data sharing between a geodatabase environment and the current "data layer" is problematic.

The second major trend, the expansion of Internet applications, has been occurring for several years and will continue into the foreseeable future. Primarily, GIS users in New Hampshire are now seeing the beginnings of a shift from an organization-based to a much broader-based system. In an organization-based system, data is stored in each agency, additional data is either created in-house or downloaded from other agencies, and processing occurs at each organization as needed. In a broader, "societal" GIS (to use the term of Jack Dangermond, founder of ESRI), less data needs to be downloaded and more can be viewed and manipulated directly over the Internet using tools embedded in web browsers.

New Hampshire is taking the first steps in this direction this year, as the first Internet mapping services become available from GRANIT agencies. Currently, the Department of Environmental Services offers a service known as OneStop Web GIS, which provides an easy interface for mapping the locations of many environmental data sets maintained by NHDES. At Complex Systems Research Center, a Conservation Lands Viewer interface has been developed, enabling web visitors to display custom maps of protected lands in New Hampshire. There has been insufficient discussion of a coherent plan for Internet-based State GIS access. In an ideal future, individual Internet mapping services affiliated with NH GIS data will become linked to each other, so that within a single GIS application, data and analysis will be supplied by several different agencies' servers. Another possible solution involves the creation of a central GIS data portal, perhaps through Webster, New Hampshire's State web site. Under this model, a "public" GRANIT data set would appear to users of the Webster GIS data portal, separate from the "live" GRANIT data under development at Complex Systems and individual State agencies. The design of an organized Web presence for NH GIS is an appropriate topic for a newly created NH GIS Steering Committee.

Fig. 1. Relation of GRANIT to State agencies, other organizations, and the general public.



4.3 Strategic Issues

4.3.1 State GIS Organization

It is generally recognized that geographic data development is most efficiently performed when agencies work cooperatively, share data and standards, and avoid duplication of effort. The NH GRANIT system has arisen to enable this very efficiency. While the current organization of GRANIT has done well in developing a statewide GIS under limited resources, this plan suggests some changes to the current structure which should help increase GRANIT's ability to carry out its mission.

The center of GRANIT data operations has been at the University of New Hampshire since GRANIT's inception. The reasons for housing GRANIT activities at UNH in 1986 are still valid today: the State's GIS benefits from being developed in an academic environment, where there is a large pool of computing expertise to draw from and a strong computer infrastructure in place and constantly being improved. For technical support, GRANIT is able to rely on the top-notch abilities of the Research Computing Center at UNH. Additionally, because Complex Systems Research Center is part of the large Institute for the Study of Earth, Oceans, and Space at UNH, GRANIT has access to data sets acquired by other EOS programs, such as satellite images. Because GRANIT is a State project housed at the State university, GRANIT is charged the lowest rate of indirect costs (35%) by the university for contractual work. Finally, Complex Systems Research Center has negotiated a software site license with ESRI, resulting in access to all ESRI software products at a significant cost savings.

As noted in Section 1, the GIS Advisory Committee was intended to be the steering body for GRANIT. Currently, while efforts to guide GRANIT activities continue to emanate from the Advisory Committee, the body nevertheless has taken on more of the character of a GIS technical users' group. Membership has been open to anyone who is interested in the development of GIS in New Hampshire, including employees of Federal, municipal, and regional agencies, as well as GIS users from the private sector. While this membership provides the valuable service of exchanging information on GIS activities in the state, thereby reducing duplication of effort, the committee as currently attended does not have sufficient representation by State agency policy-setters to effectively direct the propagation of GIS use through State government.

Additionally, New Hampshire does not have an official State GIS Coordinator. The role of coordination currently belongs to the Office of State Planning, as the lead agency of CORD, but the task of coordination is just one of many assignments currently performed at the Principal Planner level within OSP, resulting in insufficient attention being given to this important function.

To improve the State oversight of GRANIT, this plan recommends, as part of Goal #1, that a new steering committee be formed, consisting of State agency program administrators, to set policies for the continued development of GRANIT. The steering committee will have representatives from each State agency which contributes operating funds to the GRANIT project, and it will be responsible for overseeing implementation of the recommendations of this plan and the subsequent GRANIT Strategic Plan. The existing GIS Advisory Committee would be re-cast as the NH GIS Users' Group, keeping all current members and soliciting participation from additional New Hampshire GIS users from any background.

Finally, this plan recommends that a full-time State GIS Coordinator position be funded. The coordinator would work closely with both GRANIT at Complex Systems Research Center and with State agencies to implement the recommendations of this plan, including the development of statewide GIS data standards, the coordination of GIS data development activities, the adoption of GIS by additional State agencies and municipalities, and the development of a workforce skilled in GIS use. In addition, the State GIS Coordinator would function as the State's point of contact for GIS issues that relate to neighboring states and the federal government.

4.3.2 Other Strategic Issues

As noted in Section 4.2, NH GIS agencies will need to keep abreast of the rapid changes occurring in GIS software and database design. Primarily, agencies will need to budget sufficient resources for ongoing personnel training at all levels, from object-oriented programming and relational database management for GIS veterans, through basic ArcView training, to fundamental map use concepts for the most casual users.

More fundamentally, there will need to be an increase in the availability of GIS training at the secondary and post-secondary school level. Efforts should be made by current GIS personnel to promote knowledge of the field to educators and students. A good step in this direction is the growth of GIS Day. Beginning with the first GIS Day in November of 1999, it has been an opportunity for students, educators, and the public to observe GIS activities and discuss the technology and thinking that are involved. Additionally, while some individual colleges and school districts are developing curricula in GIS, the pool of qualified and knowledgeable GIS workers would be significantly increased by the support of the NH Department of Education in statewide promotion of GIS curricula.

Regarding the further development of all-encompassing Internet-based GIS applications, beyond the simple technical issues of such a development, it will be necessary for GRANIT to develop data standards that can be followed by all participating agencies, even if data is not submitted to the central GRANIT data repository at the University of New Hampshire.

A final strategic issue for GRANIT is the need to be aware of the growing number of alternative data providers, especially in the commercial sector, who are becoming active in New Hampshire. GRANIT will need to continue to raise public awareness of their own high-quality data, and at the same time provide such data and updates in a more timely manner.

5.0 Information Technology Resource Assessment

5.1 IT Technical Resources

This section describes and evaluates how well current State GIS program needs are being met by the IT environment.

5.1.1 Communications

Data is shared via the Internet primarily, and hence communications needs would be similar to those proposed for the Statewide Information Technology Plan. A significant point to remember, though, is that most GIS file exchanges require the transmission of a large volume of data. While vector-based

GIS files are relatively small (less than 1 megabyte to 5 megabytes), raster-based files are significantly larger. Digital aerial photography can quickly mount to sizes in excess of 1 gigabyte. GIS file exchange would be enhanced by an aggressive upgrade to higher-speed networks statewide.

5.1.2 Processors

GIS processors in State agencies are primarily Intel-based. Some units, especially at Complex Systems, rely largely on Unix processors. One survey respondent uses Vax equipment. GIS operations require high-speed processors, but only that which is readily available on new computers. Therefore, as long as agencies update their GIS workstations every 2 or 3 years, their equipment will be able to run current versions of GIS software without unwarranted delays.

5.1.3 Data

A large and multifaceted database of geographic information is available through GRANIT. *[See Appendix 2, GRANIT Data Catalog]* However, this data, by design, serves scales of 1 inch to 2000 feet or smaller, which is insufficient for detailed municipal or site-specific applications. Larger scale data, as developed by municipalities, regional planning commissions, and private contractors, is scattered both in area and type of data covered. *[See compilation of results to Question 7 for indication of this.]* It is therefore difficult at this time for a data user to determine what data, outside of GRANIT, might be available for a given area. This situation can be corrected by 1) further development of the GRANIT web site to incorporate data now being developed at larger scales and 2) promulgation of metadata standards to all participating agencies, to ensure that data sent to GRANIT merges well with other data and is easily found using metadata-based search engines.

5.1.4 Applications

Most GIS environments use software available from Environmental Systems Research Institute (ESRI). 82 % of GIS agencies responding to the *Survey of GIS Use in New Hampshire* use ESRI products. 50% of all GIS agencies use ESRI's ArcView package, and 17% use ArcInfo.

Operating systems are overwhelmingly Windows-based, with only 5% of respondents indicating use of Unix, Macintosh, or DOS systems.

5.1.5 Operations

Operations of IT functions are determined by individual agencies. Overall direction of data and standards development has been guided by the GIS Advisory Committee, though currently the Committee exists more as a venue for sharing of information among agencies' technical staff than for policy-setting. There is a need for more coordinated oversight of statewide GIS operations at the administrator level, a function to be served by the proposed GIS Steering Committee.

5.1.6 End-User

Traditionally, GIS end-users have been skilled spatial-science professionals who have received substantial training in their agency's GIS software as well as considerable college-level education in a related spatial field. Now, GIS use is being extended to agency personnel whose expertise lies in other

areas, through the purchase of more user-friendly software. Many end-users who currently operate software such as ArcView do not actually use more than a small percentage of its functions and can more comfortably use even simpler geographic browsing software such as ArcExplorer. It is up to the GIS professionals in State government to increase the availability of easy-to-use mapping applications to allow access to GIS data by even the most casual user.

GIS training is available through a small number of resources in New Hampshire. Currently, there is no training available through the State employee development system. GIS users are obliged to seek training either through the software vendor (such as ESRI) or to find alternative sources, the most frequently available of which is the Introduction to ArcView which is offered through the University of New Hampshire Cooperative Extension program.

According to the Survey of GIS Use in New Hampshire, 30 of the 64 responding agencies which had GIS also had a budget for GIS training. 166 employees were reported to have already received training, and 150 additional employees are slated to be trained in the next 2 years. Local agencies reported a willingness to send their employees up to 50 miles away for training, while State agencies were willing to have their employees travel up to 300 miles.

5.1.7 Development

Development of GIS tends to be agency-centric. Aside from the development of the GRANIT database at Complex Systems, which serves the entire state, remaining GIS development occurs as separate projects as each agency pursues its own mission. So far, thanks to the presence of the GIS Advisory Committee, duplicate efforts have been avoided, but as GIS activities continue to grow, greater proactive coordination will be required. Additionally, some GIS development projects, such as the creation of a statewide property map layer, will be difficult to undertake at all unless several agencies contribute resources cooperatively.

5.2 Organization and Personnel

According to the *Survey of GIS Use in New Hampshire* (December 2000), which had a 52% response rate, there were 93 full-time GIS personnel, with an additional 144 persons who used GIS software on an occasional basis.

Individual agencies follow various practices in hiring people to perform GIS operations. GIS analysts have varying titles and responsibilities from organization to organization. Even among similar organizations, such as regional planning commissions, some agencies hire personnel who are expected solely to work with GIS, while others hire planners for whom GIS is just one of many responsibilities.

Within State government, GIS operators have a wide variety of job titles, such as “Principal Planner”, “Engineer”, “Wildlife Biologist”, etc. It is therefore difficult for State agencies, when hiring, to set an appropriate salary level and advertise the correct skill requirements for a new GIS position.

5.3 Current Architecture Assessment

The central question posed here is "Can the State of New Hampshire's GIS program meet the existing and anticipated needs of State agencies and the public, given its current information technology resources?"

Because individual agencies are responsible for hardware and software purchases, it is not possible in this document to assess how well hardware and software needs are being met. It is clear that some large agencies such as DOT and DES have been assiduously upgrading their GIS computer architecture, while other agencies have been unable to commit large amounts of resources to GIS. It is hoped that a State GIS Coordinator can be helpful assisting agencies in locating or sharing resources that will help them pursue GIS development where it is indicated.

While individual agencies are responsible for personnel decisions, the State needs to improve the current offerings for personnel training in GIS. As mentioned elsewhere, training opportunities are currently scattered and sparse. The UNH Cooperative Extension Program does a good job offering ArcView training, but it is not able to provide training for all users of GIS in the State. Agencies are able to locate training from other sources as well, such as ESRI, but such courses are either irregularly scheduled or very expensive.

Because GRANIT is a central component of New Hampshire's GIS architecture, it is necessary to evaluate GRANIT's ability to maintain and distribute NH GIS data. State agencies involved in GIS have been very supportive of the role of GRANIT as the State repository for GIS data. It is very advantageous to be able to access a single location for a comprehensive selection of geographic information, and the GRANIT project has been successful in developing a statewide GIS framework and having State agencies participate in its development.

GRANIT data can be obtained through its web site at Complex Systems Research Center (www.granit.sr.unh.edu). Our goal is to have all GRANIT data available for direct download from the web site. Currently, a selection of data layers is available for direct download, while the other layers must be requested via email. As time and funding permit, Complex Systems personnel are making additional layers available. In the summer of 2002, the GRANIT web site launched its first Internet mapping application, a conservation lands inventory viewer. The future clearly will see an increase in the number of these Internet applications, and GRANIT will continue to develop additional ones as funding permits.

GRANIT data is primarily distributed in two formats currently: ESRI "coverage" format and ESRI "shape file" format. In the future, data formats will most likely switch to a geodatabase model. State agencies which already have multi-user relational database capabilities will be the first to migrate to the geodatabase model, available through ESRI products such as ArcSDE. Smaller agencies must decide whether to purchase their own multi-user database package, such as Oracle or SQL Server. If not, geodatabase activities may still be pursued in a single-user mode, using Microsoft Access. However, current software design requires that data in a geodatabase format be edited only in the most recent versions of the software. At this point, many agencies with small budgets will not be purchasing software packages which can edit geodatabases. Therefore, for the next several years, data must continue to be available in the older shape file and coverage formats, regardless of the rate of advance towards geodatabases by some agencies.

The lack of a steady funding source for GRANIT activities at Complex Systems Research Center has been the primary retardant on the development of additional data layers, on the update of existing data

layers, on the speed at which current data layers are added to the GRANIT web site for public consumption, and on the development of Internet mapping applications that would spread the use of NH GIS data to a much broader public.

5.4 Business Continuity Plan

Individual agencies are responsible for developing business continuity plans. At Complex Systems, where the majority of GRANIT data is assembled and archived, personnel perform a full backup of their data disks every six months for permanent, off-site storage. This serves as a supplement to Complex Systems' office-wide policy of routine backup, in which tapes are stored in-house and recycled every six months.

6.0 Future IT Architecture

6.1 Organizational and Procedural Component.

The primary goal in this plan is to strengthen GRANIT as the repository of State GIS data and standards. The location of the GRANIT database should remain at the University of New Hampshire – Complex Systems Research Center. A new steering committee, consisting of administrative personnel from the State agencies which financially contribute to the GRANIT project, should be created, which will be responsible for policy decisions regarding GRANIT and the implementation of the recommendations set forth in this plan. The current GIS Advisory Committee should be re-characterized as New Hampshire's GIS user group and continue its present function of serving as a clearinghouse and information exchange forum for GIS users at many different levels of government and in the private sector.

This plan also recommends that a State GIS Coordinator be hired to take charge of implementing the policy recommendations presented here. The coordinator would work with GRANIT-Complex Systems and State agencies to ensure that the tasks of data development, State agency GIS adoption, personnel training, and GIS education are carried out.

In distribution of GIS tasks, the current sharing of operations between existing State agencies and the Complex Systems Research Center at the University of New Hampshire is a satisfactory arrangement, hampered only by continued uncertainty over State levels of funding GRANIT from year to year. Therefore, a regular funding mechanism for GRANIT activities is of crucial importance. This plan recommends that the current ad hoc system of individual agencies paying user fees to GRANIT be formalized into an ongoing, multi-year system, so that funding amounts can be stabilized.

Having well-trained personnel is crucial to the successful use of GIS in any organization. As GIS usage grows among the general State employee population, agencies will need to ensure that they have a core of GIS professionals on staff who can create, edit, and maintain the agencies' geographic data. Currently, there is no State job classification series for GIS professionals. Instead, the person or persons in charge of an agency's GIS data may be classified as an engineer, a planner, or a wildlife biologist, for example, depending on which agency it is. Persons hired to perform GIS tasks currently must have training in other areas which bear little relation to the employee's actual activities. It is important that State agencies, when hiring, have a standard set of job definitions that match the jobs' true requirements. This would aid State agencies' ability to plan for job placement and would also aid persons with GIS

training who are seeking employment. This plan therefore recommends that the State create a job classification series specifically for GIS personnel, from entry-level GIS operators up to departmental GIS managers.

For agencies which already have GIS programs and operators, the need is less for additional GIS employees, but rather for increased end-usage of GIS technology by existing employees. The Departments of Environmental Services and of Transportation, for example, will be continuing to purchase additional copies of ArcView software, but they are intended to be aids to the work of existing employees.

Because the majority of GIS expansion in State government will now be towards end-user employees, the State should make GIS training available as part of regularly scheduled employee training courses, ranging from software intended for occasional users, such as ArcReader, through a desktop GIS package such as ArcView, up to software intended for GIS application programmers, such as Java, Visual Basic, and ArcIMS.

In addition, there should be an initiative to increase GIS education at the secondary and post-secondary level. GIS should be incorporated in the Statewide Education Technology Plan under development at the Department of Education.

6.2 Data Component

6.2.1 General Issues

Individual State agencies remain responsible for development of the layers of data which most directly relate to their activities. The original design of the GRANIT database in the mid-1980s assigned the development of many different data layers to various State agencies. Appendix 2 provides the current list of statewide data layers and their responsible agencies.

Data will adhere to standards set by the GIS Steering Committee and published by GRANIT. The GIS Steering Committee should evaluate the existing GRANIT standards and update them where necessary. For example, data creation methods such as GPS input and heads-up digitizing are not currently addressed by the GRANIT standards.

GRANIT data standards refer to spatial reference systems, spatial accuracy, and data integrity, and data documentation. Individual State agencies will remain responsible for maintaining standards for their own attribute data.

Data, both newly-created and updates, which are identified as part of the GRANIT system shall be transferred to GRANIT on a regular basis. The schedule for updates shall be agreed upon between the individual agency and Complex Systems Research Center. All data to be included in the GRANIT database shall have appropriate metadata developed.

6.2.2 Individual State agencies

In addition to the officially listed GRANIT data layers, the following data sets are being developed and housed by individual State agencies:

Department of Environmental Services:

- Hydrologic Areas of Concern, surface Public Water Supply Sources [Water Supply Engineering Bureau];
- Soils, for selected parts of Merrimack and Belknap counties (from NRCS mylars) [Water Supply Engineering Bureau];
- Lake Bathymetry [Watershed Bureau];
- Potential Pollution Point Sources in the seacoast region [Watershed Bureau];
- Freshwater aquatic resources [Watershed Bureau];
- Surface Water Quality Sampling Stations [Watershed Bureau];
- Watersheds for specific features such as Dams, NPDES outfalls, Registered Water Users, etc. [Dam Bureau, Watershed Bureau];
- Prime Wetlands [Wetlands Bureau];
- Centerline Hydrography [GIS Program and Geological Survey in cooperation with CSRC];
- Air Quality Monitoring Stations [GIS Program and Air Resources Division]

Office of Emergency Management:

- Critical/essential facilities
- Historical disaster data
- Evacuation routes from Vermont Yankee and Seabrook Stations
- Access control points
- Traffic control points
- Evacuation areas
- Radiological sampling and monitoring points
- Staging areas

Department of Transportation:

- New linear referencing systems for highway networks
- Highway drainage
- Guardrail locations
- Pavement striping
- Construction project locations
- Right of way information
- Highway signs and signalization
- Driveway permits

Existing data, housed at individual State agencies, receiving ongoing maintenance:

Department of Environmental Services:

- Groundwater Hazards Inventory
- UST Facilities
- Public Water Supply Sources

Office of State Planning:

- Personal wireless service facilities (cell towers)
- Graveyards
- National Register of Historic Places

Department of Health and Human Services:
- Service areas of public facilities such as hospitals

6.2.3 Data Development Through GRANIT

The original data development plan for GRANIT, as set forth in the mid-1980's, called for the creation of GIS data at a scale of 1:24,000, using the USGS 7-1/2 minute topographic maps as a base. The data development called for in the original plan is mostly completed, though some significant gaps still occur in areas such as soils mapping. Mapping at this scale has been useful for regional planning and environmental applications, but has been less useful for mapping of smaller projects such as individual land developments.

A long-term vision in the previous GRANIT data development scheme was for the creation of a set of new, larger-scale statewide data, to support detailed mapping applications, such as the relation of land ownership to physical features. This plan recommends that the State obtain funding to begin development of a large-scale statewide GIS data set, from existing sources where possible, and otherwise by new mapping. The following data layers, listed in order of need, should be included.

1. Large-scale Base Map

An ideal scale for a large-scale, statewide base map is 1:5000 (1 inch to approximately 416 feet): large enough to provide detailed resolution of built features such as roads and buildings, yet small enough to cover the entire State at a non-prohibitive cost. Vermont, nearly equal to New Hampshire in area, has successfully launched a statewide mapping project at this scale. The base map would need to be produced by the following steps:

1a. Production of large-scale (1:5000), color, ortho-corrected, digital imagery (either aerial photography or satellite imagery)

Imagery should be in color for the widest applicability to different uses, whether infrastructure mapping, or natural resources mapping. "Ortho-corrected" imagery has had distortions removed to produce data that yields precise, accurate map measurements. Distortions arise from topographic variation and angle of observation. Imagery is now routinely captured in a digital format for rapid and easy incorporation into digital image processing programs and into GIS. The choice of aerial photography or satellite imagery is left to the implementers of this plan, and depends upon the cost of data acquisition, image resolution, and the dates for which accurate and useable data can be acquired. Aerial photography traditionally yields higher image resolution, but satellites such as Ikonos are now producing digital imagery of equally high resolution.

1b. Derivation of vector base data from digital imagery provided in (1a)

Digital imagery from air photos or satellite is stored in a "raster" format, in which data is organized into an evenly spaced grid, and each location on the grid has a particular brightness value or set of values. Vector data, on the other hand, is stored as points, lines, or polygons, using coordinate geometry to define the starting points, end points, and shapes of features.

Vector data storage more accurately captures the true shape of discrete spatial features. Base map features, such as roads, trails, and railroads; stream networks; and other infrastructure such as power transmission lines and pipelines shall be derived in a vector format from the large-scale aerial imagery acquired in (1a).

1c. Large-scale Digital Elevation Model (DEM) derived from (1a) imagery, capable of producing 5-foot contours

Current USGS topographic maps show elevations at varying levels of detail, depending on the roughness of the terrain. For most of the state, topographic contours are drawn at a twenty-foot interval, though portions of southern New Hampshire are drawn at a 10-foot interval and much of the White Mountains are depicted with 40-foot contours. A digital elevation model would store elevation values in an evenly spaced grid, similar to raster data, from which contours may be calculated using surface-analysis software. The desired spacing of elevation data values in the statewide DEM would be sufficiently low to produce 5-foot elevation contours.

2. Address ranges for all streets

For every street in New Hampshire, there will be associated an address range. Specifically, each street would have a beginning and ending address stored for each of its sides. Using this information, GIS software is able to calculate a location based solely on a street address, in a process known as "geocoding". Because many State agency databases already contain street addresses, the creation of a statewide address range layer will allow rapid mapping of facilities for which the current mapping process is slow and expensive. The Bureau of Emergency Communications' Enhanced 911 mapping program has already begun the process of assigning address ranges to a large number of communities in New Hampshire.

3. Municipal boundaries from GPS surveys

Municipal boundaries are currently mapped at 1:24,000 from 7-1/2 minute USGS topographic maps. Unlike other base map features, boundaries cannot be derived from interpretation of remotely sensed imagery. Consequently, the current GRANIT municipal boundary layer is believed to have more errors than the other current GRANIT base map layers. The appropriate way to create an accurate municipal boundary layer for GRANIT is to have all boundaries surveyed using Global Positioning System (GPS) equipment, as part of the State's existing requirement that towns perambulate their boundaries every seven years.

4. Property boundaries

Creation of accurate municipal boundaries (3) is a necessary prelude to the creation of a statewide digital property boundary layer. Many towns and cities in New Hampshire have already begun the process of creating digital tax maps, as they have realized the benefit of being able to relate, using a GIS, patterns of land ownership to all other mapped features in a community, be they natural resources or infrastructure. A State committee is currently meeting to prepare standards for creation of digital property boundary data. It is expected that municipalities will submit property data, conforming to these newly developed standards, to GRANIT, as the beginning of a statewide property boundary GIS layer.

5. High resolution National Hydrographic Data Set

Production of hydrographic centerline data will enable development of a new generation of GIS applications that take advantage of stream network connectivity and directionality. Stream flow can be traced either upstream or down, so that features impacting water quality or water quantity or both can be systematically identified and analyzed. The hydrographic network provides the topological backbone for a whole class of watershed-based tools and models for water and land resources management.

6. Historical land use

Land use data has been compiled for GIS since the late 1980's, shortly after the advent of GIS in New Hampshire government. For various analytical studies, it is useful to know the patterns of land use in New Hampshire before the time of GIS. Land use data would be interpreted from aerial photos at several points in time, going back to the earliest available photos from the 1920s.

7. Zoning

Regional planning agencies have collected zoning district boundaries since the beginning of their GIS programs in 1989. Some regions have digitized zoning information for their entire areas, while others have collected zoning boundaries in a more sporadic fashion. While every zoning district in the State has its own particular characteristics, the Office of State Planning has developed a classification system that attempts to categorize zoning districts by their effects on development. In a statewide zoning layer, regional planning agencies would submit municipal zoning district data to OSP, which would then interpret the districts' land use policies and apply an appropriate classification. Care must be taken with distribution of this data to avoid misinterpretation of the land use classes.

8. Wildlife Habitat

This data layer would be coordinated by the NH Fish and Game Department, using information derived from National Wetlands Inventory, transportation, fragmented lands, and land use / land cover data to delineate areas of expected habitat for a variety of New Hampshire species.

9a. Land Use: Impermeable Surfaces

For areas of rapid population growth, there is a desire to map the extent of impermeable surfaces, such as paved areas as buildings, as an aid to modeling water supply and water quality within watersheds. Three methods have been identified for deriving impermeable surfaces:

1) Aerial photo interpretation from digital orthophotoquads. The method produces an accurate vector-based data layer, but is very labor-intensive.
2) Sub-pixel analysis of Landsat Thematic Mapper data.
3) Classification of multispectral high-resolution Ikonos satellite data. (The preferred solution.)

9b. Land Use: Large-Scale Classification

A new land cover data layer for the entire state was derived in 2001 from newly acquired Landsat Thematic Mapper data. Land cover data is derived by distinguishing different patterns of brightness on the earth's surface. Resulting land cover classes include types of forest, cleared land, water bodies, and developed land, but human use of the land is not easily categorized using this method. Large-scale land use classification is derived from aerial photo interpretation and intensive ground observation ("windshield surveys") in order to more accurately describe the types of human activity occurring.

6.2.4 Maintenance and Update of Existing GRANIT Data

The large quantity of existing 1:24,000-scale GRANIT data continues to contain great value for resource managers. For GRANIT to remain effective in meeting resource managers' needs, a program of regular data updates needs to be maintained. The following data layers will need ongoing updates in the near future:

Soil Units –The 1:24,000-scale soils layer for New Hampshire is still not complete, with Belknap, Merrimack, and Coos County data still being input. For all counties, additional soils attributes need to be entered. All soils data updates are subject to input from the USDA - Natural Resources Conservation Service.

Surficial Geology – Currently, surficial geology data exists for only ten USGS quadrangles in New Hampshire. Because groundwater supplies are primarily found within stratified surficial deposits, and because population increases and long-term drought conditions have been stressing those supplies, there is increased interest in accurate mapping of the surficial geology of New Hampshire. The State Geologist's office, within the Department of Environmental Services, is pursuing funding to perform mapping of additional quadrangles.

Floodplain Boundaries – Complex Systems Research Center has received funding to recompile the boundaries of flood zones as shown on the Flood Insurance Rate Maps (FIRMs) of the Federal Emergency Management Agency for counties in southeastern New Hampshire. The recompiled flood zone boundaries will be drawn to match National Hydrographic Dataset depictions for those counties.

Conservation Lands – This is one of the most frequently changing data layers in the GRANIT system, as a large number of organizations continue to acquire properties for land conservation. Presently, the update process is divided between the Office of State Planning, which is responsible for tracking land acquisition by State and Federal agencies; the Society for the Protection of New Hampshire Forests (SPNHF), which keeps track of non-profit agencies' land purchases; and New Hampshire's regional planning agencies, which are monitoring land acquisition by municipalities. Updates are sent to Complex Systems Research Center for incorporation of boundaries and attribute data into GRANIT. Because the update process is time-consuming and involves coordination between so many agencies, it requires better oversight than it has received to date. Plans are now being made to create a half-time position at Complex Systems, funded by SPNHF, which will be responsible for future updates of the conservation lands layer.

Digital Orthophoto Quadrangles (DOQs) – The current statewide DOQ layer was created from 1998 and 1999 aerial photography. This plan recommends a seven-year update cycle for statewide DOQ coverage, with updates occurring every three to four years for high growth areas of the state, such as Hillsborough, Rockingham, and Strafford Counties.

6.3 Applications Component

The State will increase the availability of customized GIS applications that can be used by employees with little or no GIS training, as well as by the general public. Development of these applications will center on Internet-based technology such as ArcIMS (Internet Map Server), which facilitates the creation of Worldwide Web pages that contain interactive GIS-based maps.

Specific program applications are now being developed by certain State agencies:

Department of Environmental Services:

OneStop Web GIS – general DES data set mapping viewer.

Two emergency response Systems:

1. Dam Bureau Emergency Action Plan
2. Coastal Oil Spill Response

Department of Transportation:

Electronic Records Index System for construction projects and ROW records
Records Retrieval System for scanned documents and digital images
Pavement Management System
Bridge Management System
Facility Maintenance Management System

6.4 Technical Component

The latest GIS software is being released on Windows NT and Windows 2000 platforms, with some Unix support as well. State agencies will need to ensure that computer hardware intended for GIS use is sufficiently powerful to run the software. Currently, for example, desktop GIS software such as ArcGIS 8.1 requires Windows 2000, Windows NT, or a Unix operating system, with 256 megabytes of memory recommended, but much larger configurations actually desirable, for the Windows platforms. Individual agency IT plans will specify the exact number and quality of workstations, color printers, large-format plotters, scanners, and GPS equipment to be purchased.

For GIS activities, high-speed telecommunication connections between agencies are essential. Therefore, this plan supports the ongoing development of NH SUN for State government Intranet services.

7.0 Implementation Strategy

7.1 SITP - Current and Planned Information Technology Initiatives/Projects Listing SFY 2003-2006

	Initiative/Project	Start Date	Finish	Estimated Costs		Estimated Costs	
	Title/Description	**Date**	**Date**	**SFY 2003**	**SFY 2004**	**SFY 2005**	**SFY 2006**
	GRANIT project – *current* core funding	ongoing	ongoing	$60,000	$60,000	$60,000	$60,000
	Statewide, accurate roads layer: address ranges	ongoing	2008	already in	DOT and	E-911	budgets
	Conservation Lands Layer Update Coordinator: 2 half-time positions (1 technical, 1 coordination)	2003	ongoing	$60,000	$60,000	$60,000	$60,000
	High resolution National Hydrographic Data Set – derived from existing 1:24,000 scale data	2002	2007	$35,000	$35,000	$35,000	$35,000
		Total	Costs	$155,000	$155,000	$155,000	$155,000

8. NH GIS IT Operations

8.1 SFY 2000 and SFY 2001 Projects and Expenditures

This section itemizes information technology projects and expenditures for the previous biennium (by state fiscal years).

8.2 Current Year Projects and Budgets (SFY 2002-2003)

8.3 Planning Calendar

This section outlines and describes the IT activities, projects, and budgets projected for the years 2003 - 2006. It also identifies expenditures required to operate and maintain information technology systems and applications implemented in previous years.

8.3.1 Proposed Core GRANIT Funding

The following table lists the proposed funding that would be necessary to maintain and distribute the existing GRANIT database through Complex Systems. It does not include costs for additional data development.

PROPOSED CORE GRANIT FUNDING
FY 03

SALARIES	
Staff Salaries (1)	$ 205,000
Fringe (37%)	$ 75,850
SUPPLIES	$ 3,000
TRAVEL	$ 2,500
COMPUTER SUPPORT	$ 3,000
EQUIPMENT	$ 7,500
SUBTOTAL	**$ 296,850**
F&A (35%)	$ 101,273
TOTAL	**$ 398,123**

(1) Funding requested for four full-time staff, including Project Manager, Database Manager, Web Site Manager, and Applications Manager/Cartographer.

8.3.2 Proposed Administrative Projects for NH GIS

Initiative/Project	Start Date	Finish	Estimated Costs		Estimated Costs	
Title/Description	**Date**	**Date**	**SFY 2003**	**SFY 2004**	**SFY 2005**	**SFY 2006**
GRANIT project – core funding (see table in Sect. 8.3.1) – 2% increase per yr.	ongoing	ongoing	$398,123	$406,085	$414,207	$422,491
Create GIS Steering Committee; develop bylaws	2002	ongoing	0	0	0	0
Establish State GIS Coordinator position at UNH	Jul. 2003	ongoing	0	$100,000	$100,000	$100,000
Adoption of GIS employee classification series by NH Division of Personnel	2003	2003	0	0	0	0

	Provision of regularly-scheduled GIS software training through Dept. of Administrative Services	2003	ongoing	$5000	$5000	$5000	$5000
	Update GRANIT data standards and metadata standards	2003	2003	0	0	0	0
	Develop additional Internet mapping applications for display of GRANIT data	2002	ongoing	Proposal submitted by Fay Rubin			
		Total	Costs	$443,123	$551,085	$559,207	$567,491

8.3.3 Proposed GRANIT Data Development Projects

	Initiative/Project	**Start Date**	**Finish**	**Estimated Costs**		**Estimated Costs**	
	Title/Description	**Date**	**Date**	**SFY 2003**	**SFY 2004**	**SFY 2005**	**SFY 2006**
	Large-scale (1:5000) New Hampshire base map: digital imagery acquisition	Jul. 2003	2004	$400,000 - $1.4 million			
	Large-scale (1:5000) New Hampshire base map: derivation of vector base data	2004	2005	requires input and coordination from State agencies	as to what feature types will be mapped		
	Large-scale (1:5000) New Hampshire base map: Digital Elevation Model	2004	2005				
	GPS-derived municipal boundary layer (2 staff persons)	2005	2010	$144,000	$144,000	$144,000	$144,000
	Statewide digital property boundary system	2007	??	creation of parcel standards; municipal training; outreach			
	Historic Land Use Data Set: Rockingham & Strafford Co. (entire state to follow)	2003	2006	$60,000	$60,000	$60,000	
	Statewide Zoning Layer	2003	2006	$30,000	$30,000	$30,000	$30,000

	Plant & Wildlife Habitat Layers	2003	2004	$10,000			
	Large Scale Land Use Layer	??					
		Total	Costs	$644,000 – 1.6 million	$234,000	$234,000	$174,000

9.0 Statewide Strategic IT Plan Compatibility

Type of Information	Frequency / Volume	OSP Division	Method of Distribution	Availability in Electronic Form

Appendix 1. Results of December 2000 *Survey of GIS Use in New Hampshire*

Response Rate:

Federal Govt.	9%	(1/11)
Local Govt.	53%	(117/221)
State Govt.	68%	(23/34)
Non-Profit	100%	(3/3)
Private	26%	(5/19)
Regional Planning Comm.	78%	(7/9)
School	33%	(2/6)
Total	**52%**	**(158/303)**

1) Does your agency/municipality/company currently have access to a geographic information system?

Yes **64** No **94**

"Yes" by agency type:

Federal	1
Local	34
State	13
Non-Profit	3
Private	4
Regional Planning Comm.	7
School	2

2) If "yes", is the system:

48	In-house
8	Operated by a contractor on an ongoing basis
11	Created or operated by a contractor on an occasional basis

(*Optional)* **Name of contractor:**

Responses included:

Camp Dresser McKee
Cartographics Assoc.
Central NH Regional Planning Comm.
Fuss & O'Neil
James Sewall Co.
Lakes Region Planning Comm.
Meriden Land Services
NH E-911
People GIS
Rockingham Planning Comm.
Southwest Regional Planning Comm.
Strafford Regional Planning Comm.
TerraMap
Upper Valley Lake Sunapee Regional Planning Comm.

3) If "no", is your agency currently developing plans to implement a GIS in some form?

Yes **16**

4) What GIS software are you using?

ESRI: ArcInfo: **19**
ArcView: **55**
Other ESRI: **17**
AutoCAD: **9**
Intergraph: **1**
Other: **10** *Responses Included:* AutoDesk, Delorme xmap, Dimple, GDS, Idrisi, LDD2, MapGrafix, MapInfo, and "proprietary software"

5) Under what operating system(s) does your GIS operate?

Windows 2000: **14**
Windows NT: **20**
Windows 98: **29**
Other Windows: **9**
DOS: **1**
Macintosh: **1**
Unix: **2**
Linux: **0**
Other: **1** (VaxVMS)

6) What equipment do you use for your GIS? *(please specify brands and models)*

Computers: **50**
Printer/plotters: **46** *[Brands were received but not compiled]*
Input (scanners, digitizers): **30**
GPS unit: **23**

7) What spatial data is maintained or is being developed by your organization? Please complete the table below for each data layer. The "Notes" column is available for any descriptive information you may wish to provide.

[Information has been compiled but not yet summarized]

8) What is the geographic extent of your data?

Facility level: **1**
Local: **21**
Regional: **7**
State: **10**
National: **1**
International: **2**

9) For what applications do you use your GIS?

Allocating Services: **5**
Infrastructure Management: **12**
Land Use Planning: **40**

Natural Resource Protection: **36**
Parcel Mapping: **34**
Public Safety: **19**
Site Selection: **10**
Vehicle Routing: **9**
Water Resource Planning: **21**
Other: **24**

"Other" responses included:
Hazards assessment/mitigation
E-911 addresses
Assessing
Data presentation (cartography)
Cancer cluster investigations
Environmental management
Emergency planning
Network adequacy regulation
GIS/GPS education
Fiscal planning (funding allocation)
Mapping of historical wetland boundaries
Management of forest reservations
Supplier of databases for applications
Public health
Transportation planning

10) What other GIS applications would you like your organization to be performing?

Responses included:
Internet mapping
National Hydrography Dataset (e.g. SPARROW, flow predictions)
Watershed study
Land Use
Floodplain overlay
Sewer & water system planning
Streamline planning board submission process
Public safety
Asset management/tracking
Spatial distribution of service delivery cost by category of service
Statistical modeling of land use and value
GIS-based permitting
Map school population, elderly, businesses
Manage town-wide maintenance program
Navigate to project sites using GPS
Expand educational opportunities for GIS/GPS
Site identification
Nuclear accident response
Correlations between environmental disease and exposure
Crime mapping
Insurance coverage studies
Remote sensing & image processing for change detection
Provide more in-depth assistance
Print large maps
Share historic information
Work with Census 2000 info
GPS definition of wetlands and future water supply areas (surface and groundwater)
Adjustment of tax map base to State datum
Produce orthophoto from existing 1998 data

11) How many employees use GIS?

Full-time: **93**
Occasionally: **144**

12) Can outside users access your data? How?

User can create custom maps on Internet site: **1**
User can download data over the Internet: **4**

User must request data: **35**
Data is not shared: **20**

NH GRANIT System:

13) Have you used any data from the NH GRANIT system? Yes: **48**

14) Have you created any data which you would wish to distribute to a larger public through GRANIT? Yes: **16**

15) Would you consider subscribing to an e-mail list for New Hampshire GIS users? Yes: **57**

***GIS training needs*:**

16) Do you have a budget for GIS training? Yes: **30**

17) How many of your employees have received formal training in GIS? **146** total

18) For how many employees do you plan to provide GIS training in the next 2 yrs.? **166** tot.

19) How far (miles) are you willing to send your employees for training?

Averages of responses:		
	Federal	**50 miles**
	Local	**58 miles**
	State	**250 miles**
	Non-Profit	**50 miles**
	Private	**100 miles**
	RPC	**125 miles**
	School	**3000 miles** (1 response)

20) What kind of guidance documents would be useful?

Mapping standards: **46**
RFP specifications: **17**
Statewide GIS plan: **44**
Other: **11**

"Other" responses included:
Open forum state GIS
Knowing who has what digital data, method of acquiring it, and accuracy
Basic guidelines for setup, use, and maintenance (geared towards small towns)
Procedures for specific projects (e.g. build-out analysis, FGWA)
Training
Metadata guidelines/tools
What other agencies have for projects
Coding schemes for GRANIT layers (metadata in plain English)
Employment opportunities

21) What is the biggest challenge facing the development of your GIS?

"Integrating the newest releases of GIS software to gradually replace existing versions and keeping abreast of the associated skills needed."

"Staff/tech. capabilities funding and processing/CAD software."

"Training. Our map is currently being fixed. Until the repair is completed we're unable to lay down any further layers. The other problem is that employees do not use the GIS daily and therefore skills are lacking."

"Time, money, and staffing. This also is an obstacle in educating town leaders in the advantages and possibilities of investing in GIS technologies."

"Time." "Cost and time." "Time, money, and people." "Money." "Lack of money." "Funding." "Cost." "Adequate training, time." "Waiting for the State." "Not enough time. Understaffed." "Money appreciated." "Budget constraints."[twice] "Available time." "Training (no funds) and staff time."

"Money to hire staff and buy equipment, software and web access."

"1) Cost of updating digital orthophotography & secondary cost to update planimetrics [and] topography.
2) Need for at least half-time GIS operator.
3) Speed of town network (100 Ethernet). Will eventually need to consider fiber optic network or emerging high-speed wireless.
4) Time and cost of staff to develop additional data layers. GRANIT data is great for what it is, but not at useful scale for our current level of planning.
5) The cost of maintaining/updating hardware and software."

"Time to focus on system design and community access protocols."

"Lack of time which means the system does not have a high priority to policy makers as compared to other projects."

"Money for proper training. We have a great asset available to us which would be very beneficial if we knew how. At least one of us. We [with?] this we could train the others and help at planning board session. Our town does not have an Internet hookup yet. We only have 356 residents and restricted budget."

"On July 1, 2001, Holderness will acquire GIS upon new tax maps to be delivered by Cartographic Assoc. of Littleton."

"Training. Our tax maps and assessing database has just gone on line with ArcView. We are in the early learning stage."

"Time and budget for a small town - entire system is presently under development. Financial assistance for hardware would be a great idea."

"We need more training. Showing some value to the taxpayers and elected officials. Would love more information on an ArcView users group or any training opportunities."

"Coordinating a variety of data in various software programs used by different municipal departments, such as: Vision Appraisal (Assessing Dept.), Black Bear (Building Dept.), Police Track (Police Dept.)."

"Understanding what information is available through existing sources and what has to be developed by private contractors."

"Knowledgeable, dedicated GIS personnel and time."

"1) Database availability.
2) Training time."

"We are reassessing the usefulness of the technology as an ongoing tool in light of other pressing demands."

"1) Insufficient time to allocate to development.
2) Lack of formal training.
3) Lack of a statewide, high-quality address range data layer to map individual cases/clients.
4) Confidentiality restrictions on data sharing."

"Connecting to database for reviewing projects."

"Obtaining complete and accurate data in a useable format. Also being able to obtain updates on a timely basis and being able to easily update the existing data files."

"Money (lack thereof) and resistance to change (can't teach old dogs new tricks)."

"Still don't know how to use it. Haven't been able to integrate network data into GIS to assess network adequacy."

"Time, and the lack of a dedicated person for GIS work."

"Workload - too much work for amount of employees."

"Finding an retaining qualified staff."

"Data access and management."

"Because GIS is a relatively new technology and its uses are extremely diversified, it's difficult to get clients to understand how and when GIS would be an appropriate solution."

"Programming skills." "Getting clients." "Money to buy software."

"1) Lack of funding/staff time to produce consistent coverages for each town in our region, to obtain the newest layers from state agencies, and to maintain and update our existing coverages.
2) Lack of digitized soils and floodplain data for Merrimack County."

"Funding (salaries and projects), training (schools with GIS classes, continued education), programming (training, time to write, test, debug), balancing work load and staff development."

"Integration of a wide range of qualities of data from varied sources into coherent themes."

"Metadata." "Time."

"Unmapped Merrimack County soils, varying tax map situations from town to town."

"Cost of data, locating in-depth knowledge base of software problems/programming for self-help."

"At this point it is not central to what we do everyday, but as more and more information becomes available only in electronic form (esp. from federal govt.) we see a need to develop in this area - but it will have to be added on to or in place of some other work. I don't see us getting any additional staff."

Appendix 2. Listing of GRANIT Data

FUNCTIONAL LISTING OF GRANIT DATA LAYERS - March, 2002

DATA LAYER	SOURCE / RESPONSIBLE AGENCY
GEOLOGY/SURFICIAL MATERIALS	
Bedrock Geology	NH State Geologist
Soil Units	Natural Resources Conservation Service
Surficial Geology	
Glacial Features	NH State Geologist
Miscellaneous Surficial Materials Features (exposures)	NH State Geologist
Stratified Deposits	NH State Geologist
Surficial Materials	NH State Geologist
TERRAIN	
Bathymetry	Various
Elevation - DEM	US Geological Survey (USGS)
Elevation - Hypsography (DLGs)	USGS
Elevation - Tagged Vector Contours	USGS
HYDROGRAPHY	
Aquifers	
Low Flow Stream Measurements	USGS/NH DES
Saturated Thickness	USGS/NH DES
Seismic Lines	USGS/NH DES
Stratified Drift Aquifers	USGS/NH DES
Transmissivity	USGS/NH DES
Water Table	USGS/NH DES
Wells, Borings, and Spring Sites	USGS/NH DES
Dams	NH DES
Floodplains	Federal Emergency Management Agency / Complex Systems Research Center (CSRC)
Hydrography - Surface Waters	USGS
Public Water Drinking Supply Sources	NH DES
Watershed Boundaries	NH DES
Well Locations	NH DES
Wetlands	
Coastal Wetlands	OSP
Great Bay Wetlands	UNH/Jackson Lab
NWI Wetlands	US Fish & Wildlife Service
LAND USE	
Developed Shorelines	SPOT/CSRC
Environmental Factors	

Groundwater Hazards Inventory	NH DES
Junkyards	NH DES
National Pollution Discharge Elimination System Outfalls	NH DES
Pesticides - Agricultural	NH DES/NH Dept. of Agriculture
Point/Non-Point Potential Pollution Sources	NH DES
Toxics Release Inventory	Environmental Protection Agency
Underground Storage Tanks	NH DES
Graveyards	NH Old Graveyards Assoc.
Historic and Cultural Features Inventory	OSP/Div. Historical Resources
Land Use Change	UNH/Natural Resources Dept.
National Register of Historic Places	National Park Service
OSP Recreation Inventory	OSP
Recreation Facilities	DRED
Transportation Facilities	
Pipelines	USGS
Railroads	USGS
Roads and Trails	NH DOT/USGS
SPOT Derived Land Use	SPOT/CSRC
LAND COVER	
Clear Cut Inventory	EOSAT/SPOT/CSRC
Natural Heritage Inventory	DRED/NH Natural Heritage Inventory
NH Land Cover Assessment 1995	EOSAT/CSRC
NH Land Cover Assessment 2001	EOSAT/CSRC
BOUNDARIES	
Conservation Lands	SPNHF/OSP/CSRC/NH DES
Geodetic Control	NOS-NGS/NH DOT
Geographic Names Information System (GNIS)	USGS
Political Boundaries	USGS
Statistical Census Boundaries	US Census Bureau
USGS Quadrangles	CSRC
PHOTOGRAPHY/IMAGERY	
Digital Orthophotoquads (DOQs)	USGS/CSRC
Digital Raster Graphics (DRGs)	USGS/CSRC

Appendix 3. Detailed Descriptions of Selected NH GIS Environments

Complex Systems Research Center - GRANIT Project

The Complex Systems Research Center (CSRC) at the University of New Hampshire presently serves as the primary custodian of the GRANIT System. As the host of the statewide GIS, CSRC staff is routinely involved in a set of activities related to the construction, maintenance, and distribution of the GRANIT database, which contains a suite of data sets related to planning and resource management.

Core data layers available on a statewide basis include town boundaries, roads, surface water features, topography, watersheds, aquifers (and related layers), and scanned USGS topographic quads. Additionally, data layers currently under development include a statewide land cover data set, soils data for Coos County, and an enhanced statewide hydrography layer. Data development is accomplished through a number of mechanisms, including digitizing existing maps, scanning/vectorizing existing maps, field data collection with GPS units, and processing satellite imagery.

GRANIT staff at CSRC utilizes the database to support a range of applications for various jurisdictions within the state. Current projects include the Route 2 Transportation Corridor Study (in collaboration with NH Department of Transportation), the Hazard Mitigation Project (in conjunction with NH Office of Emergency Management), and the Social Capital Assessment (in collaboration with NH Charitable Foundation). Beyond the projects GRANIT actively manages, staff participates in a number of other applications by providing technical support and access to hardware/software.

Additionally, staff is actively engaged in a number of GIS, GPS, and image processing training opportunities in the state. Current or recent training activities include provision of multi-day training to representatives of specific state agencies (NH DOT, NH OEM); in collaboration with OSP and ESRI, provision of two-day "Municipal Starter Kit" program; and in collaboration with UNH Cooperative Extension, participation in two-day and week long training sessions.

In addition to data and applications development, CSRC hosts the GRANIT web site (http://www.granit.sr.unh.edu). The site offers a number of resources to the NH GIS community, including access to GRANIT data sets, listings of upcoming events, and links to related sites. Web site enhancements currently underway include the incorporation of an interactive mapping capability to support the query and display of conservation lands in the state.

The GRANIT System at UNH is one of many projects housed at Complex Systems Research Center at the University of New Hampshire. Project-specific staff comprises six full-time and two part-time employees, including GIS specialists, image processing analysts, and technicians. Additional temporary staff is engaged as required by specific projects. The core eight-person staff has access to four administrative support personnel affiliated with the office at large, as well as fifty full-time staff associated with other funded activities in the Center. In addition, GRANIT receives computer system support from the UNH Research Computing Center, which is staffed by 13 full-time employees and a number of part-time students.

The computing environment at Complex Systems Research Center includes numerous Silicon Graphics workstations and servers (Challenge-L [4 R40000 cpu's]), PC/NT workstations, and a "near on-line" storage system with 100Gb Magneto-Optical Storage and 200 Gb Magnetic tape storage. Equipment directly relevant to the acquisition and processing of geospatial data includes 2 Trimble Pro-XRS Mapping Grade GPS Units (with real-time differential correction), a Calcomp 9500 digitizing board, CD-ROM drives, and various large and small-format color output devices. Third-party software for data acquisition, analysis, and visualization includes: Arc/Info, ArcView (including Tracking Analyst and other extensions), ERDAS /Imagine Image Processing, Oracle Database, and SAS.

In terms of funding, the NH GRANIT implementation at the University relies solely on grants/contracts for funding. An annual contract with the NH Office of State Planning and the primary cooperating state agencies provides basic support for data maintenance, archiving, and distribution

services. Project-specific contracts with other state agencies, federal agencies, and private/non-profit organizations provide additional support that is directed towards the development of targeted data sets and/or applications. Clearly, one of the major issues facing the continued development of GRANIT is the need to stabilize the project funding at a level adequate to support the increasing demands for GIS data and resources in the state.

NH Bureau of Emergency Communications (NHBEC) E-911 Mapping

Currently NHBEC 911 Mapping is involved with a substantial address conversion project. This includes not only the collection of GPS data for road and house locations but also includes the creation of a master address database that can be used for emergency response. The duties of the nine full time GIS professionals include correction of GPS data, creating and editing road data, compiling house attribute data, and computing increments for address conversion. The current production pace requires two GPS crews of two people to keep busy every day with either initial collections of an entire municipality or maintenance collections of any new structures or changes to the address map.

The three Data Control Teams of three are an invaluable asset to the Bureau. These teams are in the field every day verifying the accuracy of the data that we have compiled, and they match every phone line to an addressable structure.

Perhaps one of the most difficult obstacles of the address conversion project would be the time it takes to accurately map and compile the data. NHBEC is faced with massive amounts of data that must be collected, organized and archived with only a small production staff to complete this. These tasks require the efforts of many individuals in several capacities, so with any error there exists the possibility that a person's life may be in jeopardy.

The focus of NHBEC for the future is to stay involved with projects that are directly related to emergency response and the safety of our citizens.

NH Department of Environmental Services

The New Hampshire Department of Environmental Services (DES) GIS Program has been in existence since January 1990. Originally located within the Office of the Commissioner's Planning Unit, it was relocated in 1996 to the Information Resources Management Unit. This organizational change was performed in recognition of the importance of GIS as an agency-wide information management and analysis tool.

Since its inception, the GIS Program has been composed of two staff members: the Department's GIS Coordinator and a GIS Technician. The role of these staff is to provide technical GIS support services to other programs throughout the Department and its three divisions: Air Resources, Waste Management, and Water. These support services vary a great deal in terms of scope and complexity. In addition, the Program is responsible for coordinating the development and maintenance of GIS data for which the Department is responsible; these data now include over ten state-wide data layers that address a variety of topics relative to the Department's responsibilities for protecting, maintaining, and enhancing environmental quality and public health in New Hampshire.

The use of GIS within the Department has grown a great deal within the past ten years. This growth is due not only to advances in GIS computing hardware and software, but also to a heightened awareness of the benefits that GIS can provide. One significant manifestation of this growth is the movement away from a very centralized GIS towards a more distributed environment in which many Department staff use desktop GIS software themselves as part of their day-to-day planning and regulatory activities.

In addition to increased use directly by DES staff, the GIS Program has been working steadily over the past two years to increase public access to environmental GIS data. The first phase of this effort was the development of a public information kiosk, located at the Department main office, that allowed the public direct access to GIS and other allied information. This phase was followed shortly after by a program to publish and distribute GIS data on CD-ROM. The current phase is to provide the public with access to GIS tools and data via the World Wide Web, with a planned rollout occurring early in 2001.

Rockingham Planning Commission

The Rockingham Planning Commission has 2 full time and 1 part time staff involved in GIS activity. Staff use ArcView and PC ArcInfo to prepare maps for reports, to assist in public meetings, do some analysis and some data development. There are many spatial data sets that are maintained using GIS.

Obstacles to GIS use would include lack of staff time and difficulty of software use. GIS staff is currently required to respond to most of the planner's mapping needs, while planners could be more self sufficient in their mapping needs. Easy to use canned software/routines could be available for novice users. This points to the (in)ability of GIS staff to program. If more time were available, the planning commission could create their own 'canned software'. Financial considerations also limit the commission's ability to upgrade software.

Another obstacle to efficient use of GIS in general is the turnover rate of RPCs. The incentive to move to the private sector is substantial, GIS staff at RPCs tend to be isolated, and the ease of taking over from previous GIS staff can be difficult.

NH Department of Health and Human Services (DHHS)

The Department of Health & Human Services (DHHS) has a nascent GIS program. Currently, three programs have access to GIS and use it to fulfill their core functions.

In the Bureau of Health Risk Assessment, GIS is used for epidemiological investigations around hazardous waste sites. For these investigations, DHHS maps cancer cases from the New Hampshire State Cancer Registry to determine if the rates of disease are elevated in the community surrounding the hazardous waste site. DHHS completes three or four investigations per year.

In the Bureau of Radiological Health, GIS is used to map and analyze radon test results. DHHS maintains a GIS database of indoor air tests for radon across the state.

In the Bureau of Health Statistics and Data Management, GIS is used to map health statistics for the state. Graphical representations of some statistics are included in annual vital statistics reports, cancer reports, and for some data requesters.

In each of the three programs, one staff member is trained in GIS and conducts the analyses on a part-time basis. These three staff members act as a GIS resource to other programs in DHHS. The major obstacles to increased GIS use in DHHS are:

(1) Scarce personnel, and training, and equipment resources;
(2) Absence of a high-resolution street address data layer for the entire state;
(3) Difficulty in ensuring patient confidentiality; and
(4) Non-uniform standards for databases, spreadsheets, and other methods of data storage.

NH Office of State Planning

GIS activities have been underway at the Office of State Planning since 1988, with the purchase of PC ArcInfo software and a Compaq 386 personal computer. Since that time, computing power and software functionality has increased, as has the number of planners directly using GIS. Currently, there is one full-time GIS analyst using ArcInfo v.8 on a Windows NT workstation, plus four additional planners who use ArcView as a supplement to their other work tasks. A basic library of GIS data covering the entire state resides on the NT workstation, which, though not a server, is accessible to the other planners in the office.

GIS work at OSP functions as support for office activities, particularly in the Coastal Zone Management Program and the Land Conservation Investment Program, for which GIS analytical functions are often required. GIS technology serves as mapping support for other sections of the office, such as the Community Development Block Grants, Scenic Byways, and State Data Center programs

The major challenge facing improved use of GIS at OSP is the increasing complexity of the GIS software, where the major improvements in functionality seem to assume their use in a large office environment, where GIS applications can be developed by skilled programmers and supported by a dedicated network administrator. We intend to develop Intranet and Internet mapping applications for our office and the public, but with a total office size of 40 employees, it is difficult to commit the necessary resources to such large-scale solutions.

Government Documents Department and Data Center, Dimond Library, University of New Hampshire

The Documents Department supports courses and research at UNH and, as a Federal depository library, also serves the general public. Increasingly, the library supplies geospatial information in electronic form. However, to date, there has been little demand for GIS per se. Rather, activities have focused on helping users find digital maps on the Internet and manipulate interactive maps.

The web site for the Documents Department contains an extensive collection of scanned, but not georeferenced, historic topographic maps. There is a small non-circulating collection of current topographic maps and census data sets and software on CD-ROM. Other CD-format digital map products are frequently received, primarily from the USGS, some of which also contain the underlying data sets and some form of GIS software. Users' interests are not restricted to New Hampshire. The

Documents Department is also the state USGS Earth Sciences Information Center (ESIC) and a member of the Inter-University Consortium for Political and Social Research (ICPSR).

The Documents Department is in the process of defining what its role should be in providing GIS services. The department is unlikely to become a creator of GIS data. However, there may be ways in which it can organize, compile or interpret data. The department has ArcView software through the GRANIT site license, though currently they do not use GIS on a regular basis. At this point the emphasis is on working cooperatively with GRANIT and other GIS users on campus to determine how the department might complement their efforts and meet the needs of users who have little or no experience with GIS software. The staff is especially interested in the feasibility of providing political and demographic information in user-friendly formats.

The department provides reference services for documents and maps. However, each of the four staff members has numerous other duties. The Map Librarian has primary responsibility for the paper map collection and for leadership in defining GIS initiatives. The Data Center coordinator and the Library systems office can provide some technical assistance, but not GIS expertise. Shortage of staff is the main obstacle to expanding the department's services, although they also lack a large-scale printer or plotter and there is no publicly accessible color printing available in the library.